Geophysical Research Abstracts
Vol. 16, EGU2014-11385, 2014
EGU General Assembly 2014

Orphan Basin crustal structure from a dense wide-angle seismic profile - Tomographic inversion

Louise Watremez (1,*), K. W. Helen Lau (1), Mladen R. Nedimović (2,3), Keith E. Louden (1), and Garry D. Karner (4)

(1) Department of Oceanography, Dalhousie University, P.O. Box 15000, Halifax, NS, B3H 4R2, Canada, (2) Department of Earth Sciences, Dalhousie University, P.O. Box 15000, Halifax, NS, B3H 4R2, Canada, (3) Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, 10964, USA, (4) ExxonMobil Upstream Research Company, P.O. Box 2189, Houston, TX, 77252-2189, USA, (*) Now at: Département de Géosciences, Université du Maine, Batiment de Géologie, Avenue Messiaen, 72085 Le Mans cedex 09, France

Orphan Basin is located on the eastern margin of Canada, offshore of Newfoundland and East of Flemish Cap. It is an aborted continental rift formed by multiple episodes of rifting. The crustal structure across the basin has been determined by an earlier refraction study using 15 instruments on a 550 km long line. It shows that the continental crust was extended over an unusually wide region but did not break apart. The crustal structure of the basin thus documents stages in the formation of a magma-poor rifted margin up to crustal breakup.

The OBWAVE (Orphan Basin Wide-Angle Velocity Experiment) survey was carried out to image crustal structures across the basin and better understand the processes of formation of this margin. The spacing of the 89 recording stations varies from 3 to 5 km along this 500-km-long line, which was acquired along a pre-existing reflection line. The highest resolution section corresponds to the part of the profile where the crust was expected to be the thinnest.

We present the results from a joint tomography inversion of first and Moho reflected arrival times. The high data density allows us to define crustal structures with greater detail than for typical studies and to improve the understanding of the processes leading to the extreme stretching of continental crust. The final model was computed following a detailed parametric study to determine the optimal parameters controlling the ray-tracing and the inversion processes. The final model shows very good resolution. In particular, Monte Carlo standard deviations of crustal velocities and Moho depths are generally < 50 m/s and within 1 km, respectively. In comparison to the velocity models of typical seismic refraction profiles, results from the OBWAVE study show a notable improvement in the resolution of the velocity model and in the level of detail observed using the least a priori information possible.

The final model allows us to determine the crustal thinning and variable structures across the basin. In particular, we observe (1) a zone of extreme thinning, where the crust is thinner than 7 km; (2) basement highs and lows highlighting the blocks that accommodate the crustal thinning; (3) a central block that is thicker compared to the rest of the basin; (4) lower crustal thinning that is highly variable, which suggests a ductile deformation in the lower crust and an extensional discrepancy between the upper and lower crust (DDS); and (5) no evidence for upper-mantle serpentinization under the ultra-thinned crust. Furthermore, we show the importance of structural inheritance in rifting of the Avalon crust. Thus, we suggest that Orphan Basin is the result of rifting of a non-homogeneous Avalon terrane where the lower crust is primarily ductile.